



Forest Service
U.S. DEPARTMENT OF AGRICULTURE

Rocky Mountain Research Station Science You Can Use *(in 5 minutes)*

MARCH 2021



Seeing the Big Picture: Long Term Studies at Lick Creek Demonstrate How Fuel Treatments Impact a Changing Forest

In the early 1900s, the USDA Forest Service began harvesting the Lick Creek drainage in western Montana. As one of the earliest harvests on the Bitterroot National Forest, the work was originally documented in photographs, which have since been replicated for over 100 years. Sharon Hood, Rocky Mountain Research Station Research Ecologist who is studying the forest and ecosystem over the longer term at the [Lick Creek Demonstration-Research Forest](#), says, “The historical photographs at Lick Creek are evidence that forests are not static and show how quickly dry forests in the Rockies can change.” Thanks to the decades of long-term research at Lick Creek we can better understand and quantify these changes to inform forest management.

By the 1980s, the forest at Lick Creek had transitioned from open, seral ponderosa pine to dense stands with abundant Douglas-fir regeneration following over a century of fire suppression and selective harvesting. Two independent studies were established at the Lick Creek Demonstration–Research Forest in 1991 to evaluate the effectiveness of restoring ponderosa pine forests and reducing potential fire intensity using thinning and retention shelterwood harvests, with and without prescribed burning. Treated units were harvested in 1992 and half of the units were prescribed burned 1 to 2 years later. During the 23 years since the treatments, scientists have been collecting key information about fuels, forest structure and composition, understory species responses, tree physiology, resistance to bark beetles, carbon storage, and fire hazard. Today at Lick Creek, the overstory is still dominated by ponderosa pine for all treatments, but the smaller size class trees in the understory are primarily Douglas-fir, suggesting that without future disturbance, stand dominance will shift from shade-intolerant pine to shade-tolerant Douglas-fir-dominated forests.

Twenty-three years post-treatment, cutting and burning practices have persistently increased tree growth, even during drought. The treatments



A photo series showing how the forest changes over time. The photos show the same point in 1991 before treatment, in 1993 postharvest and immediately postburn, in 1999 seven growing seasons postburn, and in 2016 twenty-four growing seasons postburn (USDA Forest Service photos).

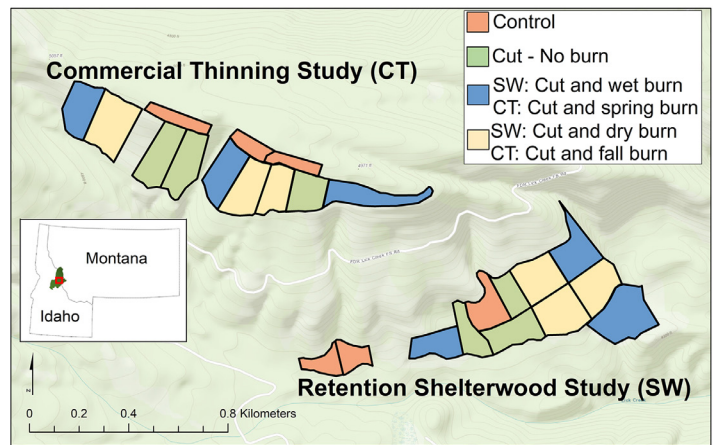


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also reduced tree mortality from mountain pine beetle. Aboveground carbon stores recovered to pre-harvest levels. Surface and canopy fuel loads as well as crowning and torching indices are now similar to untreated units, with increased ladder fuels from saplings and seedlings. However, cover of non-native understory plants such as spotted knapweed remains elevated, though at modest levels (average ~4%) relative to the peak seen 3-5 years post-treatment.

These results demonstrate that treatments aimed to reduce potential wildfire severity can have the added benefits of sequestering carbon, increasing resistance to mountain pine beetle outbreaks, and improving resilience to drought stress. There will likely also be additional benefits of enhanced growth and physiological activity under climatic stress, and the effects may persist for more than two decades. But the decades of research at Lick Creek show that to maintain these ecosystem services, fuel treatments must be part of a recurring regime of treatments used over time. Continued monitoring after re-treatments is important to determine if treatment efficacy is sustained and how non-native plant species respond.

“Long-term studies are like puzzles. They allow us to piece together lots of individual responses to treatments to help see the big picture. The numerous studies from Lick Creek show us that fuel treatments in dry forests provide many benefits above and beyond mitigating the chance of a high-severity fire,” says Hood.



The study site is located on the Bitterroot National Forest in western Montana on south facing slopes in the Lick Creek drainage. Harvesting with and without prescribed burning was conducted on the study site (USDA Forest Service map).

KEY MANAGEMENT CONSIDERATIONS

- Forest management at the Lick Creek Demonstration-Research Forest in the Northern Rocky Mountains of Montana has been documented in photographs since the [early 1900s](#) and since [1991](#) of the cut/burn treatments. These replicated photos show how quickly dry forests in the Rockies can change.
- A long-term study at Lick Creek demonstrates how fuel treatments in dry forests provide benefits beyond mitigating the chance of a high-severity fire. These benefits include persistent increased tree growth, even during drought, and reduced tree mortality from mountain pine beetle.
- Fuel reduction and restoration treatments are most beneficial with a combination of cutting and burning strategies. To maintain these benefits, cutting and burning must be repeated in a cycle that mimics the historic occurrence of fire on the landscape.
- At Lick Creek, the overstory is still dominated by ponderosa pine for all treatments, but the understory is primarily Douglas-fir, suggesting that without future disturbance, forest dominance will shift from shade-intolerant pine to shade-tolerant Douglas-fir.

PROJECT LEADS

[Sharon Hood](#) is a Research Ecologist at the Fire Sciences lab in Missoula, Montana. She is interested in fire-induced tree mortality, fire and insect interactions, and silvicultural and fuel treatment effects. RMRS scientists [Duncan Lutes](#), [Justin Croteau](#), [Yvette Ortega](#), and [Dean Pearson](#) and University of Montana faculty Christopher Keyes and Anna Sala were also involved in this work.

FURTHER READING

Hood, Sharon M.; Keyes, Christopher R.; Bowen, Katelynn J.; Lutes, Duncan C.; Seielstad, Carl. 2020. [Fuel treatment longevity in ponderosa pine-dominated forest 24 years after cutting and prescribed burning](#). *Frontiers in Forests and Global Change*. 3: Article 78.

Tepley, Alan J.; Hood, Sharon M.; Keyes, Christopher R.; Sala, Anna. 2021. [Forest restoration treatments in a ponderosa pine forest enhance physiological activity and growth under climatic stress](#). *Ecological Applications*. 30: e2188

Jang W, Croteau J, Ortega YK, Hood SM, Keyes CR, Pearson DE, Lutes D, Sala A (2020) [Native and non-native understory vegetation responses to restoration treatments in a dry conifer forest over 23 years](#). *For Ecol Manage* 481: 118684

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